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Organoleptic and Physicochemical Characterization of Ethnic Smoked Pork Delicacy (*Kinuday*) Produced by the Ibaloy Indigenous People in Cordillera, Philippines

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Descriptive sensory analysis was implemented to characterize 24- and 36-h smoked samples of pork delicacies (*kinuday*) native to the Ibaloy indigenous people in the Cordillera, Philippines. Twenty-four (24) English lexicons and their corresponding local terms were generated by eight trained panelists to describe *kinuday* samples. Characteristics of samples smoked for 24- and 36-h smoking duration in terms of color, texture, visual dryness, aroma, saltiness, and smoky flavor were compared. Smoking duration modifies the organoleptic characteristics of *kinuday* – particularly its uncooked outer skin and lean color, the cooked inner lean color, saltiness, and smoky flavor. When color is analyzed objectively, the color of skin, fat, and lean considering smoking duration as a factor is very distinct, distinct, and with a slight difference, respectively.

Keywords: Ibaloy indigenous group in Benguet, organoleptic characterization, Philippines, traditional smoked pork delicacy (*kinuday*)

INTRODUCTION

Kinuday is an Ibaloy term referring to a smoked meat delicacy produced by the Ibaloy indigenous people (IP) group in Benguet, Philippines. Benguet is among the provinces in the Cordillera that practice preserving their *watwat* (bulk of meat) obtained during festivities like *cañao*, *kedot*, *armag*, *peshit*, among others (Moss 1920). Since the household cannot consume the meat in a day, the natives hang it above their fireplace in their makeshift kitchen and is smoked until it is ready for consumption.

There are pork-based delicacies produced by various ethnolinguistic groups in the Cordillera, Philippines, and they are named differently by various groups. These native delicacies are preserved using sun-drying and smoke-drying methods. Various authors, however, generalized that the pork-based native delicacy produced in the Cordillera regardless of preservation method may be termed *etag* (Avila and Balaoing 2006; Maddul *et al.* 2015; Garambas and Balauro 2015). Consequently, Maddul *et al.* (2015) successfully established the quality characteristics for dried pork and standardized the processing methods in preparing *etag* – specifically, the amount of salt, curing duration, drying duration, and drying temperature. However, during the Technology-to-People media conference in 2011 sponsored by the Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development, natives of Benguet rejected the idea that the two products are similar even though they use the same method of preservation. The

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main argument is that *etag* is saltier, whereas *kinuday* is less salty. Hence, it is deemed that quality description is necessary to establish the qualities of the pork-based delicacy produced by the Ibaloy IP group.

Although the quality characteristics of sun-dried and smoke-dried pork (*etag*) were established, detailed organoleptic characterization of each of the native delicacies was not taken into account. Therefore, the distinction between native delicacies was not ascertained and remains equivocal. Establishing *kinuday's* properties disentangles the perplexity regarding its distinction with other smoked meat products produced by other groups in the Cordillera, claiming its rightful dub. Hence, the research characterized a traditionally prepared Benguet smoked pork delicacy (*kinuday*).

MATERIALS AND METHODS

Samples

Kinuday samples were produced by an Ibaloy who practices the traditional manner of smoking meat. Meat from native pork was processed continuously for 24 and 36 h. Two replicate production runs were carried out. Ethical clearance was sought (Code: 2019-011-Garambas-Kinuday) before the conduct of the study from the Department of Science and Technology–National Ethics Committee.

Research design. In this study, a randomized complete block design was utilized with production run as the blocking variable. Each block contains two treatments (24- and 36-h smoked meat samples) that were served randomly to each panelist. Descriptive sensory analysis was used to determine the characteristics of the smoked pork samples. This method sought to profile meat samples on their perceived sensory characteristics (Murray *et al.* 2001).

Sensory Evaluation

Panelists' profile. Eight trained panelists consisting of four females and four males, ages 30–59 yr old who were either *kinuday* consumers or processors were recruited to evaluate the samples. All panelists understand and speak the Ibaloy language fluently. Also, they were recruited based on their ability to understand and speak the Ibaloy language fluently.

Selection and training of panelists. The panelists were selected and trained before the evaluation of the *kinuday* samples. Purposive non-probability sampling was employed in the selection of trained panelists. Initially, 12 panelists were selected according to the following criteria: [1] Ibaloy who can understand and speak the Ibaloy language fluently, [2] age ranged from 30–59 yr, and [3] consumer or processor of *kinuday*. The remaining eight panelists were trained and evaluated the quality characteristics of the smoked pork in terms of the samples' color, aroma, texture, visual dryness, saltiness, and smoky flavor.

During the first session of the selection process, a taste and odor recognition test was conducted. Besides identifying the odor and taste of each sample, panelists were asked to describe the odor and taste in English and Ibaloy terms. The second run of the selection process determined the ability of the panelists to rate the intensity of a basic taste. Panelists were asked to evaluate the saltiness of varying sodium chloride solutions. The third test in the selection process was a discrimination test, specifically a triangle test, to assess the panelists' acuity to discriminate one product from the other. Two smoked meat samples produced by different indigenous groups in the Cordillera were utilized in this test. Score sheets for basic odor and taste recognition, intensity ranking, and discrimination tests were utilized. A quality identification sheet was utilized to describe the *kinuday* samples' characteristics in terms of color, aroma, texture, visual dryness, saltiness, and smoky flavor. The same sheet was used to generate English and Ibaloy lexicons. After lexicons were generated, the descriptors were rated using a 150-mm line scale (Schilling *et al*. 2018). Various food samples were prepared for odor recognition, taste acuity, intensity rating, and discrimination test. Water and unsalted crackers, distilled bottled water, spoons, spit cups, and tissue paper were provided for each panelist.

In preparation for the actual evaluation of *kinuday* samples, the remaining 10 panelists attended a series of training. The 36-h smoked pork was used as the warm-up sample. The panelists were asked to provide descriptors for the warm-up sample in terms of color, aroma, texture, saltiness, and smoky flavor. The panelists developed final descriptors in English and Ibaloy and established reference samples. The 10 trained panelists were calibrated through repeated evaluations to obtain almost similar evaluation ratings.

Actual evaluation of food samples. During the actual evaluation of food samples, eight panelists were left. The panelists evaluated the smoked meat samples and generated perceived attributes (Schilling *et al*. 2018; Villarino *et al.* 2007) in terms of color, aroma, visual dryness, texture, saltiness, and smoky flavor. The intensity ratings generated from the reference served as a guide for the panelists in evaluating the characteristics of *kinuday* samples.

Color analysis. For color analysis, one pack of 250 g uncooked *kinuday* samples processed for 24 h and the same weight for 36 h were used. Each sample was packaged and coded, indicating the differences between

the samples, and submitted to a third-party laboratory. HunterLab A60-1014-593 Filmware Version 1.07 and Above Manual Version 1.1 was used in the analysis.

The skin, fat, and lean color of *kinuday* samples were measured using the L*C*h° color space measurement. Color measurements of all samples were repeated six times. The L* (lightness – darkness), a* (redness – greenness), and b* (yellowness – blueness) were measured and recorded. The color space coordinate differentials ΔL*, Δa*, and Δb* were computed recorded values of 24-h smoked meat and 36-h smoked meat. The L*, a*, and b* were likewise used to derive the total color difference (ΔE*) – the magnitude of color difference between the 24-h smoked meat and 36-h smoked meat – using Equation 1:

$$\Delta L^* = L^*_{\text{24-hour smoking}} - L^*_{\text{36-hour smoking}}$$
$$\Delta a^* = a^*_{\text{24-hour smoking}} - b^*_{\text{36-hour smoking}}$$
$$\Delta b^* = b^*_{\text{24-hour smoking}} - b^*_{\text{36-hour smoking}}$$
$$\Delta E^* = \sqrt{\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}}$$

The C* refers to chroma, and its value is 0 at the center and increases according to the distance from the center, whereas the hue angle h is defined as the angle between the hypotenuse and 0° on a +a* axis and is expressed in degrees. The 0° would be at +a*(red), 90° would be at +b* (yellow), 180° would be at –a* (green), and 270° would be at –b*(blue) (Konica Minolta 2007). Chroma and hue are computed using Equation 2.

$$\text{Chroma } C^* = \sqrt{(a^*)^2 + (b^*)^2}$$
$$\text{Hue Angle } h_{ab} = \tan^{-1}\left[\frac{b^*}{a^*}\right]$$
$$\Delta H^* = \sqrt{(\Delta E^*ab)^2 - (\Delta L^*)^2 - (\Delta C^*)^2}$$
$$= \sqrt{(\Delta a^*)^2 - (\Delta b^*)^2 - (\Delta C^*)^2}$$

DATA ANALYSIS APPROACH

The standard deviation and coefficient of variation (CV) were used to determine the dispersion of generated values from the perceived quality scores of samples among trained panelists to calibrate the chosen panelists and result in almost similar perceptions during the actual evaluation.

Paired *t*-test was used to determine significant differences (0.05 level of significance) in intensity ratings between 24 and 36 h of meat smoking in terms of color, aroma, texture, visual dryness, saltiness, and smoky flavor. Microsoft Excel was used in the analyses of data.

For instrumental color analysis, the L*, C*, and h° of the 24- and 36-h uncooked smoked pork samples were statistically analyzed using paired *t*-test.

RESULTS AND DISCUSSION

Organoleptic Characterization of *Kinuday*

The panelists evaluated the *kinuday* sample smoked for 36 h as the warm-up sample and generated lexicons to describe *kinuday* samples' color, aroma, tenderness, visual dryness, saltiness, and smoky flavor. The panelists discussed terms appropriate to describe the characteristics of the sample. The panel leader initiated the discussion as to the correct Ibaloy equivalent of the English descriptors. After a series of discussions and relevant comments were integrated, a final list of descriptors and definitions was generated (Table 1).

Organoleptic characteristics of *kinuday* are described in terms of color, texture, aroma, visual dryness, and taste considering the meat state (cooked or uncooked), surface area (outer and inner), and meat part (skin, lean, and fat). Uncooked outer color of the skin, lean, and fat is described as dark or burnt (*etoling*), brownish red (*aambalenga*), and brownish yellow (*shoyaw*), respectively. Uncooked inner color for skin is dark (*etoling*), reddish (*binmalenga*) for lean, and cream (*empoti*) for fat. The texture of uncooked kinuday is described as soft (*endofet*) for fat, tough (*endayot*) for lean, and firm (*enbanalbal*/ *makneg*) for the skin. The aroma of uncooked kinuday is described as smoky (*naasohan*). For the visual dryness for uncooked *kinuday*, fat is described as moist (*embebasa*/ *maleneb*/ *madeneb*) and dry (*emag-anan*/ *emag-an*) for the lean part. For the cooked, the outer and inner surface color of the skin, lean, and fat is similarly described as the uncooked. The smoky aroma of the cooked sample gained the same descriptions as the uncooked samples. The texture of cooked *kinuday* for the fat part is described as soft (*endofet*), tender (*endofet*) for the lean, and chewy (*mansoykot*/ *mansokjot*) for the skin. Finally, the taste is described as just enough saltiness (*mansep-it*) and smoky (*naasohan*).

During the second training session, the panelists were asked to identify the descriptors and definitions of food products. After a few conversation exchanges, the panelists were able to come up with references to compare attributes of *kinuday* samples (Table 2). The reference standards utilized include brewed coffee for color, fresh pork belly for uncooked lean color, cream cheese for texture, smoked bacon for aroma and taste, and gummy candy for chewiness. Other reference standards were adopted from Villarino *et al.* (2007) and Meilgaard *et al.* (2007).

Table 1. Descriptors and definitions of attributes to describe *kinuday* samples.

Attribute	Ibaloi term	Definition
Uncooked samples		
Color (outer surface)		
Skin: dark/burnt color	*Etoling*	The intensity of skin color from light to dark
Lean: brownish red	*Aambalenga*	The intensity of lean color from red to brownish-red
Fat: brownish yellow	*Shoyaw*	The intensity of fat color from yellow to brownish-yellow
Color (inner surface)		
Skin: dark	*Etoling*	The intensity of skin color from light to dark
Lean: reddish	*Binmalenga*	The intensity of lean color from reddish to brownish red
Fat: cream	*Empopoti*	The intensity of fat color from cream to white
Texture		
Fat: soft	*Endofet*	Force required to fully compress product between thumb and index finger from no force to high force
Lean: tough	*endayot*	Force required to fully compress product between thumb and index finger from no force to high force
Skin: tough	*Enbanalbal/ Makneg*	Force required to fully compress product between thumb and index finger from no force to high force
Aroma		
Smoky aroma	*Naasohan*	The intensity of the smoke aroma from none to strong
Visual dryness		
Fat: moist	*Embebasa/ Maleneb/ Maleneb*	The amount of wetness/ oiliness on the surface from moist to dry
Lean: dry	*Emag-anan/ Emag-an*	The degree to which the lean part looks from dry to very dry
Cooked samples		
Color (outer surface)		
Skin: dark/burnt color	*Etoling*	The intensity of skin color from light to dark
Lean: brownish-red	*Aambalenga*	The intensity of lean color from red to brownish-red
Fat: brownish-yellow	*Shoyaw*	The intensity of fat color from yellow to brownish-yellow
Color (inner surface)		
Skin: dark	*Etoling*	The intensity of skin color from light to dark
Lean: reddish	*Binmalenga*	The intensity of lean color from reddish to brownish red
Fat: cream	*Empopoti*	The intensity of fat color from cream to white
Aroma		
Smoky aroma	*Naasohan*	The intensity of the smoke aroma from none to strong
Texture		
Fat: soft	*Endofet*	Force required to compress through the food sample at first bite from tender to tough
Lean: tender	*Endofet*	Force required to compress through the food sample at first bite from tender to tough
Skin: chewy	*Mansokjot/ Mansoykot*	Force required to compress through the food sample at first bite from chewy to very chewy
Saltiness		
Saltiness is just enough	*Mansep-it*	The intensity of saltiness from no salt detected to very salty
Smoky flavor		
Smoky	*Naasohan*	The intensity of the smoke taste from none to strong

Table 2. Standard reference intensity ratings used in the descriptive sensory analysis of *kinuday*.

Attribute	Reference standards	Intensity[a]
Uncooked samples		
Color (outer surface)		
Skin: dark/burnt color	Brewed coffee[b]	150
Lean: brownish red	Fresh pork belly (Monterey)	60
Fat: brownish yellow	Yellow food color (McCormick) 0.1 ml/L	50
Color (inner surface)		
Skin: dark	Brewed coffee[b]	150
Lean: reddish	Fresh pork belly, lean part (Monterey)	60
Fat: cream	Fresh pork belly, fat part (Monterey)	10
Texture		
Fat: soft	Cream cheese (Magnolia) served at room temperature	25
Lean: tough	Cream cheese (Magnolia) served at room temperature	25
Skin: tough	Cream cheese (Magnolia) served at room temperature	25
Aroma		
Smoky aroma	Smoked bacon (Purefoods)	65
Visual dryness		
Fat: moist	Fresh pork belly (fat concentration) (Monterey)	50
Lean: dry	Fresh pork belly (lean concentration) (Monterey)	55
Cooked samples		
Color (outer surface)		
Skin: dark/burnt color	Brewed coffee[b]	150
Lean: brownish-red	Fresh pork belly (Monterey)	60
Fat: brownish yellow	Yellow food color (McCormick) 0.1 ml/L[c]	50
Color (inner surface)		
Skin: dark	Brewed coffee[b]	150
Lean: reddish	Fresh pork belly (Monterey)	60
Fat: cream	*Taho* (purchased from local *taho* vendor)	65
Aroma		
Smoky aroma	Smoked bacon (Purefoods)	65
Texture		
Fat: soft	Cream cheese (Magnolia)[d]	10
Lean: tender	Cream cheese (Magnolia)[d]	10
Skin: chewy	Gummy candy (Purchased in a local supermarket)	135
Saltiness		
Saltiness is just enough	Salt solution (NaCl) 0.55 g/ 100 mL[e]	10
Smoky flavor		
Smoky	Smoked bacon (Purefoods)	45

[a]Intensity ratings are based on 150-mm line scales
[b]2 cups of ground coffee to 1 L of water brewed in a percolator for 20 min
[c]Adopted from Villarino *et al.* (2007)
[d]Meilgaard *et al.* (2007, p. 264)

Intensity ratings gathered from the panelists were analyzed through descriptive statistics – specifically, standard deviation – to determine the variability of responses. Those panelists whose ratings were not within ± 10 were calibrated by asking them to re-evaluate the references until consensus was met. The ± 10 decision for limiting the variability of responses is based on the study of Villarino *et al.* (2007). Reference standards standardized by Meilgaard *et al*. (2007) utilized in this study include the use of cream cheese for tenderness (softness, toughness, and firmness) and the use of salt solution (NaCl) as a reference standard for saltiness. The use of yellow food color to determine color intensity was adopted from Villarino *et al*. (2007). The panelists decided on other food products as reference standards to determine the intensity of *kinuday* qualities. The standard deviation result indicates that the panelist's responses for each of the food samples cluster around the mean. Further, since the standard deviation of the scores is within 10 points of the mean rating, panelists are deemed to be calibrated. Hence, the consensus means intensity values obtained were utilized as reference standard values to evaluate the organoleptic characteristics of *kinuday* samples.

The CV for each descriptor was computed to reach a consensus among panelists. Ratings from the trained panelists were calibrated through repeated evaluations to obtain almost similar evaluation ratings. Since all ratings are within ± 10, panelists were considered calibrated.

A paired *t*-test was run on eight trained sensory panelists to determine whether there was substantial evidence of the mean difference between the 24- and 36-h smoked *kinuday* samples' color, aroma, texture, visual dryness, saltiness, and smoky flavor. A 150-mm scale was used to determine the intensity ratings of the *kinuday* characteristics. A comparison of mean differences of sensory characteristics between two samples is presented in Table 3.

Color. Previous studies on smoked pork products mainly described the general pork color such as brownish-red for *etag* (Maddul *et al.* 2015); and brownish-red and yellowish fat for smoked belly pork strips (Issenberg and Lustre 1970). Hence, in this current study, the color of *kinuday* in terms of pork state (cooked or uncooked), surface area (outer and inner portion), and meat part (skin, fat, and lean) were taken into account.

Kinuday's dark skin color generated after smoking is brought about by two factors: the singeing process of the swine carcass and the soot produced from the burning of wood used in smoking the pork slices. The result of the *t*-test shows that the *t*-computed value of 2.54 is greater than the *t*-critical 2.365 with an associate *p*-value of 0.039. Hence, there is substantial evidence that the outer skin color intensity of uncooked *kinuday* smoked for 24 and 36 h is significantly different. The result further denotes that the outer skin color of uncooked samples smoked for 36 h is darker than the sample smoked for 24 h, as indicated by the intensity ratings of 125 and 120.7, respectively. Therefore, the result means that the difference in the smoking duration results in a discernible difference in skin color of *kinuday*. Sikorski (2004) observed that as the smoking temperature and duration increase, the darker the color of the resulting meat. For cooked *kinuday*, the *t*-test result indicated by the derived *t*-computed, which is 1.16, is lower than the *t*-critical (2.365). Data further signifies that regardless of smoking duration, the skin color intensity of *kinuday* is almost similar. Boiling the smoked meat disintegrates the soot that covers the meat skin. Thus, the dark color perceived by the panelists in the cooked *kinuday* samples is influenced mainly by the singed skin during the slaughtering process and, partially, the soot penetrated the skin of *kinuday* samples.

For the color of the lean part, the result of the *t*-test reveals that the *t*-computed value, which is 2.61, is greater than the *t*-critical of 2.365 with an associated *p*-value of 0.035. Hence, there is substantial evidence that the outer lean color intensity of uncooked *kinuday* between 24- and 36-h smoking is significantly different. The result further connotes that the brownish-red color of the lean meat smoked for 36 h is more prominent and of greater intensity than its counterpart. Therefore, the result indicates that the difference in the smoking duration results in a discernible difference in the uncooked lean color of *kinuday*. The *kinuday* smoked for 36 h is closer to brownish red color or with higher color intensity than the 24-h smoked *kinuday*. On a general note, the brownish-red (*etotoling*) color is only detected on the outer surface of the lean meat since the inner portion of the meat is perceived as reddish (*binmalenga*). This brownish-red color on the surface is a combined effect of the Maillard-type reactions during smoking and smoke compounds deposits from the burning wood (Poligne *et al.* 2001). Rahman (2006) elaborated that Maillard-type non-enzymatic browning reactions contribute to meat's external surface color, which involves the reaction of carbonyl compounds with amino groups.

Regarding the samples' fat color, the *t*-test result indicates no significant disparities relative to the surface (outer and inner) and meat state (cooked or uncooked). The latter statement is supported by the *t*-computed values of the uncooked outer and inner fat colors, which are 1 and 1.39, respectively – lower than the *t*-critical value of 2.365 with an associate *p*-value of 0.351 (outer fat color) and 0.211 (inner fat color). Concerning the cooked outer and inner fat color, *t*-computed values 0.93 and 0, respectively, are lower than the *t*-critical value of 2.365 with an associate *p*-value of 0.385 and 1. Such a result implies that regardless of the length of smoking duration, panelists evaluated the

Table 3. Analysis for *kinuday* samples' characteristics.

Quality characteristics		**Smoking duration**		***T*-value**		***P*-value**
English terms	Ibaloy translation	24 h	36 h	*T*-stat	*T*-critical	
		mean	mean			
Uncooked samples						
Color (outer surface)						
Skin: dark/burnt color	*Etoling*	120.7	125	–2.54	2.365*	0.039*
Lean: brownish red	*Aambalenga*	129.3	132	–2.61	2.365*	0.035*
Fat: brownish yellow	*Shoyaw*	130	131.6	–1	2.365	0.351
Color (inner surface)						
Skin: dark	*Etoling*	106.7	108	–0.64	2.365	0.542
Lean: reddish	*Binmalenga*	77.81	80	–2.2	2.365	0.064
Fat: cream	*Empopoti*	10.5	11.31	–1.38	2.365	0.211
Texture						
Fat: soft	*Endofet*	39.06	39.88	–1.3	2.365	0.236
Lean: tough	*Endayot*	119.4	125.4	–1.83	2.365	0.109
Skin: firm	*Enbanalbal/ Makneg*	133.4	134.1	–0.72	2.365	0.497
Aroma						
Smoky aroma	*Naasohan*	82.56	87.56	–1.89	2.365	0.101
Visual dryness						
Fat: moist	*Embebasa/ Maleneb/ Maleneb*	82.56	83.44	–0.4	2.365	0.701
Lean: dry	*Emag-anan/ Emag-an*	121.4	124.8	–1.47	2.365	0.185
Cooked Samples						
Color (outer surface)						
Skin: dark/burnt color	*Etoling*	113.4	115.3	–1.16	2.365	0.285
Lean: brownish red	*Aambalenga*	125	126.3	–1.18	2.365	0.278
Fat: brownish yellow	*Shoyaw*	125.8	127.2	–0.93	2.365	0.385
Color (inner surface)						
Skin: dark	*Etoling*	104.6	105.9	–0.7	2.365	0.506
Lean: reddish	*Binmalenga*	41.13	45.69	–2.7	2.365	0.031*
Fat: cream	*Empopoti*	10	10	0	2.365	1
Aroma						
Smoky aroma	*Naasohan*	85.63	87.5	–0.93	2.365	0.382
Texture						
Fat: soft	*Endofet*	124.1	123.8	0.226	2.365	0.828
Lean: tender	*Endofet*	87.69	89.38	–0.7	2.365	0.509
Skin: chewy	*Mansokjot/ Mansoykot*	104.1	103.6	0.40	2.365	0.699
Saltiness						
Saltiness is just enough	*Mansep-it*	21.06	23.75	–3.24	2.365*	0.014*
Smoky flavor						
Smoky	*Naasohan*	75.13	88.56	–6.61	2.365*	0.003*

*Significantly different if t-stat ≥ t-crit, $\alpha = 0.05 <$ p-value

color of the fat portion similarly. The color of the fat portion, if viewed on the outer portion, is brownish yellow (*shoyaw*) and cream (*empopoti*) when viewed on the inside surface. The brownish-yellow color of the *kinuday* fat agrees with the finding of Sikorski (2004), stating that the resulting meat smoked using oak, nut, and alder is with yellow-brownish tint. However, the yellow tint observed in smoked meat darkens as smoking increases (Fellows 2017). The perceived brownish-red in lean meat tissue and brownish-yellow fat color of smoked meat have long been observed as smoked meat characteristics by Issenberg and Lustre (1970). Meanwhile, the cream color of the inside portion of the *kinuday* appears to be almost the same as raw pork fat. However, based on the evaluation, the fat color of *kinuday* developed a cream color compared to the prominent white color of the fresh pork fat.

Texture. T-test indicates that no substantial evidence that 24- and 36-h *kinuday* in terms of texture considering the different parts of the smoked meat (lean, fat, and skin) is significantly different. Such claim is substantiated by the derived *t*-computed values of the fat part (1.3), lean part (1.83), and skin (0.72) – which are less than the *t*-critical value at 2.365 with associated *p*-values of 0.236 (fat), 0.109 (lean), and 0.497 (skin). Such a result denotes that regardless of the smoking period, the texture (lean, fat, and skin) of *kinuday* is rated similarly. For the uncooked samples, the fat portion is described as soft or *endofet*, tough or *endayot* for the lean part, and firm or *enbanalbal*/ *makneg* for the skin portion. Whereas the observed reduced fat content of meat during smoking is considered to be beneficial to health, Puljic *et al*. (2019) and Kafouris *et al*. (2020) argue that during smoking, the possibility of polycyclic aromatic hydrocarbons (PAH) development is high, specifically for smoked food products smoked in traditional and uncontrolled conditions.

According to the Ibaloy who produced the smoked meat samples, the longer the smoking duration, the firmer the fat becomes. However, since the *kinuday* samples were smoked for a short duration (24 and 36 h), the fat remains generally soft. Still, when compressed between the thumb and index finger, the force exerted is three times higher than fresh meat (Table 1). Regarding the tough texture of the lean meat, this is brought by reduced water activity induced by both curing and smoking. As methods applied to *kinuday*, dry curing and smoking make the meat tough and decrease digestibility, increasing storage stability (Gomez *et al.* 2020; Hui *et al*. 2012).

The texture of the cooked *kinuday* samples is described as soft or *endofet* for the fat portion, tender or *endofet* for the lean, and chewy or *mansokjot*/ *mansokyot* for the skin. From the tough texture of uncooked *kinuday*, the lean part becomes tender when boiled for 30 min. This mechanism occurs during the cooking process and alters the color, texture, and flavor – rendering improved meat digestibility (Hui *et al.* 2012).

Aroma. Paired t-test results denote no significant differences in the intensity of smoky aroma of *kinuday* samples considering smoking duration since the *t*-computed, which is 1.89, is less than the *t*-critical (2.365) with the associated *p*-value of 0.101. The result denotes that regardless of smoking duration, the perceived intensity of the smoky aroma of the *kinuday* is almost the same. Radovcic *et al*. (2016) gathered the same result that in terms of smoky aroma, intensity ratings are not significantly different regardless of manufacturer, ripening, and smoking duration of Dalmatian smoked dry-cured ham. Fellows (2017) explained that four factors influence the absorption of smoke – density, humidity, temperature, and the moisture content of the material to be smoked. The higher the smoke density, the greater the absorption of smoke compounds. The higher the smoke humidity, the absorption of smoke water-soluble compounds increases because vapor condenses on the food surface. Finally, if the food surface is too dry, there is less penetration of smoke – thus leading to loss of flavor and, at the same time, preservative action. Therefore, this premise explains that regardless of smoking duration, the intensity of the smoky aroma is perceived to be equal. The result, however, is in contrast to the result gathered by Pu *et al*. (2020) that pork with a longer smoking duration is perceived to have better sensory qualities – specifically with strong meaty, smoky, roasty, woody, and greasy attributes – compared to shorter smoking duration.

Visual dryness. The paired *t*-test result indicates no significant disparity in the intensity ratings for the visual dryness of fat and lean meat regardless of smoking duration since the derived *t*-computed for fat (0.4), and lean (1.47) are lesser than the *t*-critical, which is 2.365. The fat of the *kinuday* is described as moist or *embebasa*, and the lean portion is dry or *nak-kitan*. The result further means that regardless of smoking duration, *kinuday's* visual dryness (fat and lean) is perceived to be the same. Regarding dryness, Poligne *et al*. (2001) explained that the reduction of fat moistness leads to fat cell dehydration because of the heat caused by burning wood during smoking. The cell walls are damaged, prompting a flow of fused fats.

Saltiness. The paired *t*-test result indicates that the *t*-computed, which is 3.24 is greater than the 2.365 *t*-critical value with the associated *p*-value of 0.014. Hence, there is substantial evidence that the saltiness of *kinuday* samples between 24- and 36-h smoking is significantly different. The disparity in the taste between 24- and 36-h smoking duration is detectable. The result concurs with the finding of Maddul *et al.* (2015) that the longer the smoking duration, the resulting meat becomes

saltier because salt is more concentrated during the smoking process.

Smoky flavor. T-test result signifies substantial evidence that the smoky flavor is significantly different since the t-computed value obtained, which is 6.61, is much greater than 2.365 t-critical with the associated p-value of 0.003. This result connotes that the difference in the smoking duration is sufficient to detect a discrepancy in *kinuday's* smoky flavor. The smoke flavor can penetrate the skin and meat surface since smoke permeates organic surfaces (Hui *et al*. 2012); hence, the longer the meat surface is exposed to smoke, the more the meat is saturated with smoke.

Instrumental Color Analysis

The skin, fat, and lean color of *kinuday* samples were measured using an L*C*h° color scale. ΔE* or color difference between 24- and 36-h smoked pork was likewise determined. The result of the analysis is presented in Table 4.

For the hue, the red-purple is placed at the far right or at an angle of 0°. Following counterclockwise, yellow is at 90°, bluish-green at 180°, and blue at 270° (McGuire 1992). Based on the derived value of hue at 67°40" (24-h smoked pork) and 63°27" (36-h smoked pork), the hue coordinates for *kinuday's* skin color are identified between the shades of yellow and red. Paired *t*-test result indicates no significant difference between the hue of *kinuday's* skin between 24- and 36-h smoking duration since the *t*-stat is 1.53 is lower than the *t*-crit, which is 2.23. It further means that regardless of smoking duration, the hue of skin is of the same degree. Compared to the subjective evaluation conducted, the human subjects perceived a significant difference, but instrumental color analysis reflects otherwise. For the fat color of the 24- and 36-h smoked pork, the hue coordinates identify the samples as close to yellow shade with the derived values of 75°39" and 78°51, respectively. The paired *t*-test result denotes a significant difference in the hue of *kinuday's* fat between the 24- and 34-h smoking duration as indicated by the *t*-stat value, which is 2.34 – higher than the *t*-crit (2.23). The result further implies that smoking duration imposes a difference on the fat color in *kinuday* making. Despite the significant difference detected by the instrument not perceived by human subjects, the presence of the yellow shade as detected by the instrument was likewise perceived by the sensory panelists since they described *kinuday's* fat as brownish-yellow. Finally, for the lean color of the smoked pork, the hue coordinates lie between red and yellow both for the 24-h (58°58") and 36-h (56°28") duration. When values are statistically analyzed using paired *t*-test, no significant difference is found since the *t*-stat (1.81) is lower than the *t*-crit (2.23). The result means that the hue of *kinuday's* lean is of the same degree regardless of smoking duration

Looking at the derived values for chroma in general, the skin, fat, and lean colors of the 24-h smoked pork sample are less vivid than those of the 36-h smoked pork. However, when treated statistically, there is a significant difference in color intensity or vividness of *kinuday* smoked in 24 and 36 h when fat and lean are considered but no significant difference in *kinuday's* skin color.

The intensity of *kinuday's* skin color smoked in 24 and 36 h when treated statistically using paired *t*-test. No significant difference is found, considering that the

Table 4. Color attributes of *kinuday* samples.

***Kinuday* samples**	**H°**	***t*-stat**	**C**	**ΔC***	***t*-stat**	**L***	**ΔL***	***t*-stat**	**ΔE***
Skin									
24-h smoked	67°40"	1.53	5.4	1.84	2.13	22.21	–2.69	2.01	3.26
36-h smoked	63°27"		7.28			24.90			
Fat									
24-h smoked	75°39"	2.34*	16.31	1.78	7.06*	38.77	–1.24	3.96*	2.21
36-h smoked	78°51"		18.53			48.99			
Lean									
24-h smoked	58°58"	1.81	15.20	0.88	9.61*	36.98	–1	1.63	1.49
36-h smoked	56°28"		16.06			37.92			

Values generated are an average of six trials per replicate run of two
t-crit value is 2.23; *significantly different if *t*-stat ≥ *t*-crit
H° – hue
C* – chroma; ΔC* – change in chroma
L* – lightness to darkness; ΔL* – change of L*;
ΔE* – total color difference (<= 1.0: not perceptible; 1–2: perceptible through close observation; 2–10: perceptible at a glance; 11–49: colors are more similar than the opposite; 100: colors are exactly the opposite)

value of *t*-stat (2.13) is lower than *t*-crit (2.23). This also means that the intensity of *kinuday*'s skin is almost the same irrespective of smoking duration. The result further infers that regardless of smoking duration, the intensity or the chroma of *kinuday*'s skin remains the same. For the *kinuday* samples' lean color, the 36-h smoked pork is perceived to be more vivid or intense than its counterpart. Paired *t*-test statistical analysis supports this claim since the derived *t*-stat (9.61) is greater than the *t*-crit, which is 2.23. The sensory panelists likewise perceive such a significant difference. The statistical result further indicates that smoking duration affects the vividness or intensity of *kinuday*'s lean color. Finally, for *kinuday's* fat color, the paired *t*-test result reveals a significant difference when smoking duration is compared since the derived *t*-stat value (7.06) is greater than the *t*-crit, which is 2.23. The result denotes that smoking duration imposes a difference on the intensity or vividness of *kinuday*'s fat color.

For L* or the lightness or darkness of *kinuday*'s sample, the color analysis reflects that the 36-h smoking duration is darker than the counterpart. However, when treated statistically, significant differences are found in *kinuday*'s fat and lean color but not on the skin color. Paired *t*-test reveals that there are no significant differences in terms of L* for *kinuday*'s skin and lean color since the computed *t*-stat, which are 2.01 (skin) and 1.63 (lean), are lower than the *t*-crit (2.23). The results mean that irrespective of smoking duration (24 and 36 h), the lightness or darkness of *kinuday*'s skin and lean color are almost comparable. If *kinuday's* fat color is taken into account, a significant difference is detected as reflected by the *t*-stat value, which is 3.96 – higher than the *t*-crit (2.23). The result further indicates that smoking duration impacts the lightness or darkness of *kinuday's* fat color.

In terms of ΔL* (lightness – darkness), the skin color of 36-h smoked pork is darker than the 24-h smoked pork as reflected from the negative value computed. This result concurs with the sensory evaluation result where the difference is significant in terms of skin color considering smoking duration as a factor. To reemphasize, Sikorski (2004) elaborated that as the smoking temperature and duration increase, the darker the color of the resulting meat.

Meanwhile, the ΔE* or the total color difference, Gabriel *et al*. (2017) explained that disparities in the perceivable color of the smoked pork are classified as very distinct (ΔE* > 3), distinct (1.5 < ΔE* < 3), and small difference (ΔE* < 1.5). Taking this reference into account, the observed color differences for skin, fat, and lean considering smoking duration as a factor is very distinct, distinct, and with a slight difference, respectively. Additionally, ViewSonic (2021) explained that ΔE* is measured on a scale from 0–100. The 0 value indicates less color difference, whereas 100 indicates complete distortion or the exact opposite. The ΔE* values for skin and fat are 3.26 and 1.24, respectively, which – when interpreted – means that the color difference between the 24- and 36-h smoked pork for both skin and fat is perceptible at a glance. While the lean meat color difference between 24- and 36-h smoked *kinuday* (1.49) is perceptible through close observation. When using the interpretation of Sharma (2004), the derived skin and fat color difference between 24- and 36-h smoked pork corresponds to just a noticeable difference since the derived values (3.26 and 2.21) are around 2.9.

CONCLUSION

Smoking duration affects the organoleptic characteristics of *kinuday* – specifically, its outer skin and lean color (uncooked), the inner lean color (cooked), saltiness, and smoky flavor. The characteristics not affected by smoking duration include uncooked outer surface fat color; uncooked inner surface skin, lean, and fat color; cooked outer surface lean, fat, and skin color; cooked skin and fat color; uncooked and cooked aroma and texture; and visual dryness. Longer smoking duration imposes higher intensity in terms of color, saltiness, and smoky flavor.

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